THE INSTITUTE OF PHYSICS
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BULLETIN

No. 54 JUNE, 1954

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The Bulletin is not intended for general circulation : your copy should not therefore be passed to a library.

NORTHAMPTON POLYTECHNIC
St. John Street, London, E.C.1

VACUUM TECHNOLOGY SUMMER SCHOOL

An intensive course (lectures and practical work) on vacuum technology will be conducted from September 13 to September 24. It is intended for workers in industrial firms and research organizations, Government laboratories, etc. Applicants should have a general knowledge of physics of approximately degree standard.

Further particulars may be obtained from the Head of the Physics Department at the Polytechnic.

APPOINTMENTS VACANT

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

The Royal Technical College, Glasgow. (Affiliated to the University of Glasgow).

Department of Electrical Engineering.

Lecturer in Electronics. Applications are invited for a lectureship in electronics, salary scale £600 – £50 – £1150. Candidates should possess a good honours degree in Electrical Engineering, and have had some experience in servomechanisms. The duties will include undergraduate and postgraduate teaching and research. Forms of application may be obtained from the Secretary of the College.

University of Queensland, Australia. Applications are invited for the position of **senior lecturer in physics.** Applicants should possess a higher degree or an equivalent qualification in physics and should have had lecturing experience. Research experience will be taken into account.

Salary £A1295/£A1495 p.a.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is July 17, 1954.

The Medical Research Council has a vacancy for a **physicist** in its Radiotherapeutic Research Unit, to work on the clinical applications of the 8 MeV. Linear Accelerator, including the dosimetry of the X-ray and electron beams. Some experience in hospital physics will be an advantage, but is not essential. Salary in accordance with age and experience. Applications to the Director of the Unit, Hammersmith Hospital, Ducane Road, London, W.12.

Monmouthshire Education Committee. Technical College of Monmouthshire, Crumlin. Applications are invited for the following posts available at the above College in September next :—

(1) **Assistant Lecturer in Physics.** Candidates must possess a good honours degree in this subject, and it is desirable that they should have had research and/or industrial and teaching experience. Salary in accordance with the Burnham Technical Scale for Assistants Grade "B."

(2) **Graduate** to teach two of the subjects of physics, chemistry and mathematics, chiefly to the standard of Ordinary National Certificate. Industrial and/or research experience desirable. Facilities for research available to suitably qualified candidate. Salary in accordance with the Burnham Technical Scale for Assistants Grade "A."

Further details and forms of application obtainable from the Director of Education, County Hall, Newport, Monmouthshire, and must be returned not later than June 19, 1954.

University of Reading. Applications are invited for posts as **research assistants** in the physics department to work on problems connected with semi-conductors and other aspects of solid state physics. Candidates should possess a good honours degree in physics. Previous experience in solid state physics is desirable but not essential. Salary according to qualifications and experience. A successful candidate who does not already possess a research degree will be encouraged to work for one. Applications, together with the name of two referees should be sent to the **Professor of Physics, Physics Research Laboratories, 78 Upper Redlands Road, Reading, Berks.**

THE INSTITUTE OF PHYSICS

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THE PHYSICIST IN THE ELECTRONIC ENGINEERING INDUSTRY

By R. E. BURNETT, M.A., A.M.I.E.E., A.Inst.P.
(*Marconi's Wireless Telegraph Co. Ltd., Chelmsford*)

The demand for more scientists and engineers in government research establishments, industry and the teaching profession, and the need for better facilities for higher technological training in this country, are both subjects which make headline news to-day. The evidence published from time to time by the Technical and Scientific Register of the Ministry of Labour and National Service and also by the various University Appointments Boards, clearly shows that the demand for physicists is still very great. It is not perhaps widely realized that part of the present day demand for physicists is due to the growing recognition of their value in work not directly concerned with physics research. I was recently looking again at the Report published in 1949 of the Hankey Enquiry Committee on the supply and demand for persons with professional qualifications in Physics. This report, while acknowledging the appreciable demand for physicists required for research, forecast the need for men of a practical bent " who can apply the wide knowledge of physics gained in a University Course to the everyday problems of development, production and control." Elsewhere it goes on to emphasize that there was much evidence of a requirement for men whose training had been largely in physics but who had " the practical outlook engendered by some experience in engineering or technology."

THE VALUE OF A PHYSICS DEGREE

Many young men graduating in physics at the Universities regard with suspicion a suggestion that they might consider an appointment as a physicist engineer. They appear to suspect that they are being wooed only because industry cannot obtain all the engineering graduates it needs, and that they might in consequence find themselves regarded as the poor brethren of the engineers. The depth and complexity of the numerous engineering problems posed by the ever increasing *tempo* of scientific discovery makes the knowledge represented by a physics degree as much an essential basis of the engineer's training as that represented by an engineering degree. A broad scientific training, a practical outlook and the ability to apply scientific methods to

day-to-day problems, are all qualities which combined are very much needed in many branches of the engineering industry to-day. To take a specific example, in the light current electrical industry where one is concerned with the design of technically complex electronic devices, not only must there be the scientists to design the complicated circuitry involved, but the Industry must also have technologists to ensure that equipments are of first rate design. It is common knowledge that this country must export complex well engineered equipments rather than mere simple mass-produced apparatus which some of our foreign competitors are better able to manufacture cheaply than we are. If one looks at the qualifications of the electronic engineers in a large modern light current electrical manufacturing firm it is not uncommon to find that almost one-third of the professional men took degrees in physics at the Universities, the other two-thirds being mainly electrical engineers. It is my belief that this proportion of physicists may have to increase—it must certainly not decrease.

THE PHYSICIST IN THE RESEARCH DEPARTMENT

The man with a physics degree in the electronic industry may be engaged in one of many activities. To take the most straightforward first, he may be employed in a Physics Department engaged in what could rightly be called pure physics research into such subjects as semi-conductors and transistors, the use of ferrites in waveguides, vacuum physics, magnetism and so on. The Physics Department itself in any light electrical engineering firm is bound to be relatively small. The majority of the firm's technical staff must of necessity be engaged on problems directly concerned with electronic engineering. But these may range from purely scientific problems such as the behaviour of electromagnetic waves over the whole radio spectrum, through the more applied problems such as those of circuitry and microwave techniques, to the engineering problems of the design of apparatus for manufacture. It may be true that only the exceptional physics graduate is likely to find his way into the Physics Department itself, but the scope for the " run of the mill " man is extraordinarily wide and interesting and offers, incidentally, a much greater range of opportunities for initiative and, for that matter, advancement.

THE PHYSICIST IN DESIGN AND DEVELOPMENT DEPARTMENTS

Although there is a scarcity of qualified men in all fields, I think it would be true to say that it is in what is known in industry as the design and development departments that the scarcity is greatest. The design or development engineer, the man responsible for producing the prototype apparatus which will be passed to the production departments for manufacture, has a most stimulating and satisfying task to

undertake, and in this field there is so much to learn that a designer who becomes competent is bound to be a key man in any organization. It is my experience in interviewing a large number of young newly-graduated physicists that they are prejudiced against development

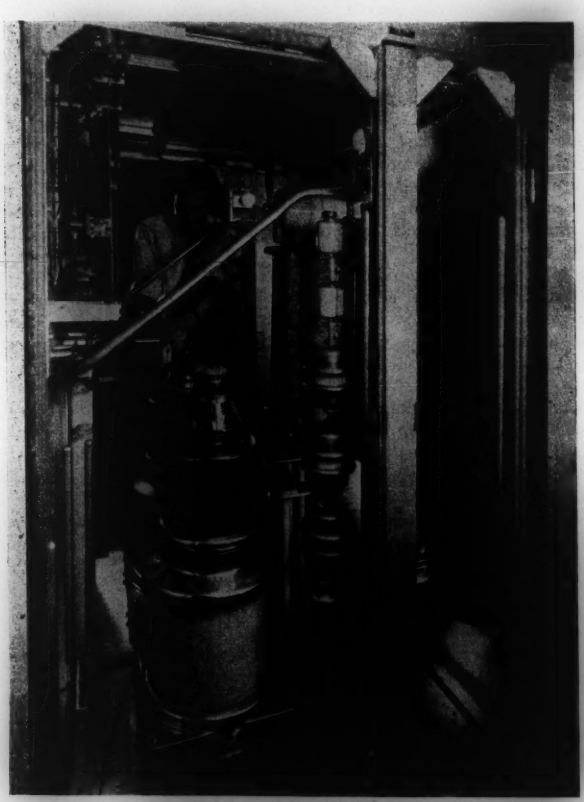

Fig. 1 — Large valves and other components in the final r.f. stage of a 100 kW broadcast transmitter.

engineering as a rather dull and routine business, somewhat beneath their intellectual level. In point of fact, a development engineer must have as sound an appreciation of the basic underlying science as any research engineer. He must be able to take over from the Research Department reports of their investigations and absorb them without difficulty. Starting with these reports, he must be capable of designing or supervising the design of the electronic circuitry and the mechanical aspects of the apparatus. These mechanical problems may themselves range from the design of small intricate mechanisms to the design, for example, of a physically large 100 kW broadcasting transmitter. So much for his technical knowledge. He must also have other knowledge which has to be obtained largely as a result of experience. He must know a good deal of the operational use of the equipment which he is designing. He must consider whether the apparatus will withstand the climatic conditions in which it is to be used. He must bear in mind the technical limitations of the men who will operate his equipment in the field, and the need for reliability and serviceability. Another specialist department of which the designer should have some knowledge is that of production engineering. The research engineer, in making his lash-up model, can add components to a chassis in a haphazard way, whereas the development engineer must have continuously in mind such production problems as simplicity of manufacture, cost and availability of materials. Lastly, he must be a man with some sympathy towards the problems which arise in the sales department. In short, the work of the development engineer, far from being dull or monotonous, is creative and stimulating, and it is, incidentally, of vital importance to Britain's economic recovery. Many of our best development engineers took their first degree in physics and to this basic scientific training they added knowledge of these other subjects, acquired mainly in the hard school of experience as well as from formal courses on design.

THE PHYSICIST IN PRODUCTION

In the fields of manufacture and production the physicist is also needed and is in fact being found in increasing numbers. Here again, his basic scientific training, his enquiring mind, his habit of constructively reviewing rather than blindly assuming the virtue of accepted practice, are making a vital contribution to our productivity.

SALES AND CUSTOMER LIAISON

For the purpose of completeness, I should mention that physicists who have the appropriate personal qualities are also employed on technical sales work and customer liaison, but, here, personal qualities are of paramount importance.

THE DESIRABILITY OF POST-GRADUATE TRAINING

The use of physicists in these diverse departments, some of which I have described above, raises the question of the desirability of some form of training for the direct entry from the University. In the past most of the " know-how " of the development engineer has been gained by experience and by working alongside a more experienced colleague. Someone once said that experience mainly enables one to perpetuate the mistakes of one's forefathers. Although there may be an element of truth in this dictum it must be admitted that experience is essential before a man can become a good designer and I believe that there is no complete substitute for it. Nevertheless, by the old methods it took some five to seven years after graduation to produce a competent designer and with the serious shortage of technologists to-day we must consider any method of reducing this time. If the functions of the designer are defined as precisely as possible it soon becomes clear that some of the techniques can be taught and some of the experience of older men can be passed on to enable the junior to learn more quickly than by the old method of leaving him to learn only from his mistakes.

Fig. 2 — Tests being conducted on an experimental v.h.f. multichannel link.

For these reasons I favour the present tendency to give the newly-graduated physicist some form of training on joining industry, partly so that he can learn the techniques necessary for him to play an effective part in the organization, and partly to ensure that he has some opportunity of learning about the whole organization which he has recently joined, and the functions of its different departments. Here again, I should like to refer to the 1949 Report of the Hankey Enquiry Committee, where it is recommended that many physicists should have "some form of training in industry comparable with the apprenticeship of an engineering graduate, although of shorter duration." Admittedly, the honours degree physicist can join a research department and be set to work straightaway on a scientific problem, but there is a danger here that he may become somewhat narrow and limited in his outlook, and have little or no knowledge of many of the Company's activities. The majority of men taking finals in physics at a University tend to regard the research department as the only one in which they could and should look for employment. To some extent, I think, this is due to the fact that in the Research Department they can see work being done which appears to be somewhat similar to the type of work they have been doing in the University laboratory during their physics degree course. They feel at home doing this experimental work. Furthermore, the word "research" has a certain amount of glamour associated with it. Others, among them some of the most intelligent, when asked what they would like to do, will say that they have not sufficient knowledge of the opportunities in industry to make a choice. This seems to me to be a perfectly reasonable answer to the question, and part of the early training of a new entrant should be designed to enable him to gain first-hand experience of a number of departments and to attend lectures by Divisional Chiefs on the work of their own departments. In this way, after a period of 12–18 months, the new entrant to the Company should be able to form some opinion of the direction in which he would like to aim.

THE NEED FOR INDUSTRY TO RECRUIT MORE UNIVERSITY GRADUATES

The person responsible for the recruitment and training of technical staff has two distinct psychological problems to face, the first relating to the prospective entrant, the University graduate, the second to the entrant's prospective boss, the Management. I have considered above the need to convince the newly appointed entrant to industry that there is much for him to learn before he can play an effective part in the Company, particularly if he wishes to equip himself to rise to higher management.

With secondary school education now available to larger numbers of the community and with the number of University scholarships at

least doubled compared with 1939, a high proportion of schoolboys of the upper intelligence level now have opportunities of going to the University, which before the war were limited to the privileged few. One result of this is that fewer boys of high intelligence are now available for employment in industry in the 16-18 age group, and more are entering Industry at the graduate level. The second psychological problem, therefore, is to convince the older supervisors and managers that the University graduate, although he may be ignorant of applied techniques, is bringing to the Company intelligence and scientific training which will enable him to assimilate knowledge quickly and in the long run make him a most vital member of any team. In fact, Industry is getting more valuable material in these graduates than in the days when it was customary to join Industry at 16 or 18 years old.

POST-GRADUATE TRAINING COURSE

Most of the post-graduate training courses now available in industry are planned to suit the needs of individuals, partly to fill in gaps in the knowledge of the man concerned, and partly to equip him for the particular sphere in which he thinks he would like to work. Normally such courses begin with a period of a month or two on basic workshop principles, instrument making and use of machine tools. (If a man is already familiar with this or has done it during his vacations then this part of the training is omitted). This may be followed by a short period of attachment to the manufacturing departments. This part of the training should be organized to enable the young graduate to obtain an overall picture of the organization of a works, and he should be given specific assignments which will enable him to see for himself the works system and methods. He should see something of works and cost accounting, stores procedures, time study and so on. The third part of the training should consist of attachment to a research or development laboratory. Here again, every effort should be made to put the trainee on to a specific project. If possible, he should be allowed to design some small piece of apparatus with limited guidance from a more experienced engineer. Towards the end of the training period the students are interviewed individually and discuss with responsible officials whether their future should be planned with a view to a career in Research Development, Production or Sales. In one or two organizations there is a fourth part to the training programme, which consists of a full-time advanced course on design and development techniques. Such a course should be essentially practical in its approach and, as all students have already graduated, the content of the syllabus should be at an advanced level.

POST-GRADUATE DEGREES

A man with a post graduate degree does not normally take any formal training, as he has already had post-graduate training in the techniques of research, and he would enter the department of his choice at once. He should, however, attend the general lectures on the Company organization and on design techniques.

OTHER INDUSTRIES

I have dealt in this article with the industries with which I am most familiar, but I have seen first-hand evidence of comparable problems and solutions in the scientific instrument industry, and latterly I have watched with interest the last stronghold fall to the attack of the physicists, namely the heavy mechanical engineering industry. Here again, physicists are in demand for the twofold task of investigating specific scientific problems which arise in the industry, and of bringing their minds to bear on the design and manufacturing processes. A new field which will become of increasing importance will be in the applications of atomic energy to industrial processes. Operational research, for which the academic training of the physicist provides an

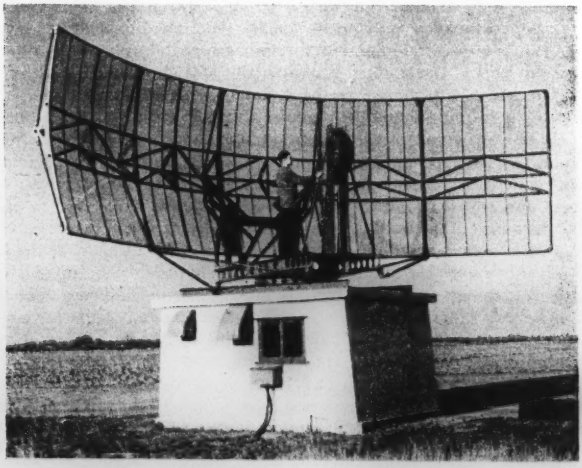

Fig. 3 — Front view of a radar aerial system.

excellent background, is another technique of importance in certain industries.

PERSONAL QUALITIES

Perhaps we should touch in brief on the subject of personality, which is of paramount importance to those who aspire to the higher posts in Industry. The number of posts in Industry where personal qualities are of little moment is so small as to be almost negligible. I believe that professional competence and a mature personality are of equal importance when assessing the value of a member of the staff. The one is of little value without the other. To-day leadership—as distinct from autocratic dictatorship—is required at all levels. Energy, enthusiasm and freedom from prejudice are all qualities needed to-day, but perhaps above all the ability to gain the respect and the loyalty of both one's juniors and one's seniors will command the greatest success. Our educational systems and our Universities are fully aware that it is part of their function to encourage the development of personal qualities in a man as well as to increase his knowledge. The degree to which they succeed depends of course on the raw material with which they have to work, and also on the standing and tradition of the school or University. I believe that educated men of good intellect who have understanding and skill in human relationships will make the best managers. These qualities are partly innate, but also partly the result of environment and education.

CONCLUSION

It is relevant to note that a few Universities are already producing the applied physicist or physicist engineer. Students who have completed such courses satisfactorily very soon begin to make an effective contribution in Industry and for such graduates any post-graduate training courses can be reduced in duration. While Industry may welcome this tendency on the part of certain Universities, the academic world would do well to be cautious in accepting any pressure on the part of Industry to persuade them to increase their applied or technological approach. On the whole, Industry itself—with help from its local Technical Colleges—must undertake training in applied techniques. The Universities have a greater part to play in the service of mankind in ensuring that men's minds are developed sociologically in such a way that we may learn to use the frightening advances in scientific knowledge for the betterment of mankind and not for its destruction.

I have attempted to show in this article that ~~in industry the~~ physicist is no longer the poor brother of the engineer and the administrator. While it is vital that many of our physicists be engaged in pure physics

research, there are now new fields and interesting opportunities waiting for the man with the physics degree who would like to widen the scope of his activities and who is prepared to study for a further year or two after leaving the University.

If young men of first-rate intelligence and scientific training are prepared to apply their talents to help in increasing the quality of Britain's engineering products and if managements on the other hand are prepared to create an atmosphere in their factories in which these young men can give of their best there is no doubt that this country can regain its position as the foremost exporter of high grade engineering products.

THE PHYSICAL SOCIETY : SUMMER MEETING, 1954

The Physical Society Summer Meeting will take the form of three lectures given in connection with the General Assembly of the International Union of Pure and Applied Physics, and will be held at the Royal Institution, 21 Albemarle Street, London, W. 1, on Wednesday, 7th July, at 4.30 p.m., Friday, 9th July, at 4.30 p.m., and Monday, 12th July, at 2.30 p.m.

The programme will be as follows :

Wednesday, 7th July, 4.30 p.m. Fields and Particles, by Professor J. A. Wheeler (Palmer Physical Laboratory, Princeton University, U.S.A.).

Friday, 9th July, 4.30 p.m. The European Organization for Nuclear Research, by Professor E. Amaldi (Instituto di Fisica " Guglielmo Marconi," Rome, Italy).

Monday, 12th July, 2.30 p.m. Microwave Experiments in the Physics of Solids, by Professor C. Kittel (University of California, Berkeley, California, U.S.A.)

Non-members of the Physical Society are welcome to attend the meetings ; tickets for admission will *not* be required.

THE WORK OF THE HOSPITAL PHYSICIST

By R. G. WOOD, M.Sc., A.M.I.E.E., F.Inst.P.
(*The Royal Infirmary, Cardiff*)

The penetration of physicists into hospital work is a comparatively recent development which has taken place to a greater extent in this country than in any other. The earliest regular contact of physics with medicine came through the departments of physics in some of the medical schools attached to London hospitals. Although primarily engaged in teaching, the staffs of these schools were bound to become interested in the physical aspects of medical problems which came to their attention. These teaching posts, however, differed in character from hospital physics posts proper, which developed later and which are primarily concerned with day to day clinical problems in the hospital. Hospital physics in this sense began in departments of radiotherapy when it was realized that the physicist could play an essential part in the scientific control of the treatment of disease by X-rays and gamma-rays.

The basic physical problem in radiotherapy is the delivery of a specified quantity of X- or gamma-radiation, uniformly distributed throughout a given volume of tissue with minimum radiation outside. With X-rays this may be achieved by combining a number of overlapping beams, directed in succession at the volume to be irradiated from different directions outside the body. Less commonly the same end is reached by arranging continuous relative motion between the patient and the source of X-rays : the patient, for example, may be rotated about a vertical axis in a fixed beam, or the X-ray tube may execute oscillations through large or small angles keeping the central ray always passing through a fixed point. In recent apparatus even more complicated motions are possible and the problem of dosage estimation at any point in the patient becomes very complex. In planning such treatments it is necessary to know the distribution in space of the X-radiation intensity in a given beam falling on a scattering medium similar to body tissues. The measurement or calculation of " isodose curves " for this purpose has been, and still is, a very important part of the physicist's work (Figs. 1 and 2). By means of such curves a map of dosage distribution for any combination of fields can be drawn and the best arrangement chosen for the treatment of any particular tumour. The inhomogeneity of a real patient, who consists of bone and air-spaces as well as water-like tissue, is usually neglected in practice, though this aspect of the problem has not been entirely neglected.

If radium is to be used as the source of radiation, the physical problem is the specification of the proper geometrical distribution and strengths of the radium containers relative to the volume to be treated,

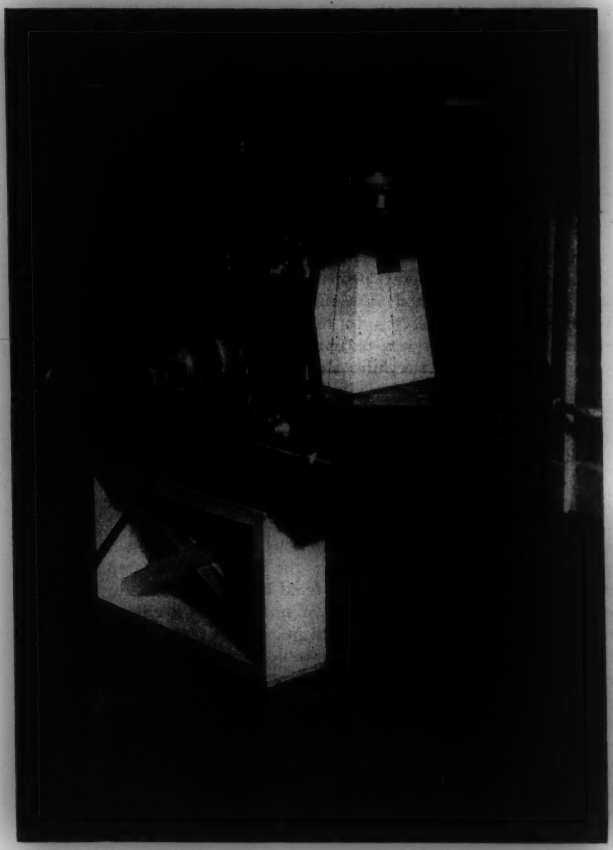

Fig. 1 — Micro-chamber immersed in water phantom for measurement of X-ray dose distribution. Chamber can be moved in two directions at right angles by remotely controlled Synchro-motors.

and afterwards the calculation of the treatment time for the distribution actually achieved. This distribution may be very close to the ideal as in radium mould treatments, or it may diverge widely as sometimes happens in a difficult implant. For practical application general physical principles have been established and in the simpler cases the radiotherapist is able to apply these without difficulty. Medical and anatomical considerations will often prevent the use of the method

Fig. 2 — X-ray control room showing remote control for Synchro-motors of Fig. 1 in the foreground, and vibrating reed electrometer. A spot of light follows the motion of the micro-chamber and enables isodose curves to be plotted directly.

which seems best from a purely physical point of view and it is then, and in difficult cases, that the physicist is of greatest assistance, since he can often suggest methods of calculation or measurement which will give a solution to the problem. It is obvious that the closest co-operation is required between the radiotherapist and the physicist and each must appreciate the other's point of view and difficulties.

A great step forward occurred when international agreement was secured on the definition of a unit quantity of radiation (the röntgen), applicable both to X- and gamma-rays, and in a form amenable to measurement. The setting up of a more fundamental unit applicable also to other ionizing radiations which may find medical application in the future is one of the problems at present under discussion. Many new types of irradiating apparatus working at higher and higher voltages are being introduced ; for example, Van de Graaff and other types of generators working at 1 or 2 MeV, linear accelerators working in the range 4-15 MeV and synchrotrons at 30 MeV or more. The conventional X-ray tube is also being replaced to some extent by sources containing large quantities of radioactive isotopes, such as cobalt 60, iridium 192 or caesium 137. These pieces of equipment present numerous problems of their own in design, in protection, in servicing and in calibration.

The advent of radioactive isotopes with their numerous applications to medicine in fundamental research and as aids to diagnosis and therapy has added much to the work and responsibilities of physicists in hospital. Many of the applications of radioactive isotopes have no direct connection with radiotherapy and the physicist has thus been brought into contact with many other branches of medicine. Each isotope presents its own problems of measurement and requires appropriate safety precautions. The radiotherapist must always be interested in radiation delivered to a patient for whatever reason, and in all cases this type of work should be under the joint supervision of the radiotherapist and the physicist in close co-operation with the physician concerned.

The physicist in a radiotherapy department is concerned not only with radiation received by patients. He must be responsible for the protection arrangements required to safeguard the staff from the ill effects of radiation at low dose rates received over a long period. This involves work as varied as the design of protective walls for treatment rooms, the testing of radium containers for leakage, and the regular measurement of the small doses of radiation received by radium and X-ray workers in the course of their duties. The hospital physicist is thus concerned with measuring radiation doses and dose-rates over a very wide range of magnitudes. His equipment must include ionization chambers of all sizes, electrometers of many types, photographic film badges, Geiger and scintillation counters, and other instruments for the detection and measurement of ionizing radiation. An example of a vibrating reed electrometer is shown in the photograph (Fig. 3) which also includes a number of ionization chambers of different types. Where isotopes are in use the far more insidious risk of inhalation and ingestion of radioactive materials is added to the

hazard of external irradiation and the physicist must be alert to all the dangers involved and see that proper precautions are taken. In this field the safety of patients and staff alike demands the most careful attention to detail.

So far it would appear that the hospital physicist is exclusively concerned with ionizing radiations and their effects and measurement. It is true that there are very few hospital physicists at present who are not concerned to a greater or lesser extent with this problem, but it is not to be expected that physicists to-day, any more than their predecessors, will be content to restrict their activities to one department when numerous problems call for their assistance elsewhere. A short step from radiotherapy leads to the X-ray diagnostic department where obvious problems concerned with radiation protection of staff and patients often need investigation. Other physical problems concerned with the improvement of the radiograph and the operation of the equipment call for the attention of the physicist ; so far, however, there are but few diagnostic departments employing full-time physicists, though many call upon them for occasional help and advice.

Electronic apparatus finds increasing application in medical work. It is of course used extensively in the measurement of ionizing radiations, but there is a much wider field than this. The human body develops small potential fluctuations in many of its activities and the amplification and display of these fluctuations is of great value in certain diagnostic procedures. The first to be discovered and used were the potential fluctuations arising from the beating heart, and the electrocardiograph which displays these is the commonest of all instruments of this type. The electroencephalograph recording brain potential fluctuations through the skull is more elaborate and presents more difficult problems of technique and interpretation. The electromyograph for the observation of muscle potentials is the latest of these instruments and its indications are the most difficult to interpret. Through these and other devices a hospital physicist will come into close contact with many branches of medicine and discover many problems awaiting solution. In physical medicine, for example, there are problems connected with the measurement of infra-red and ultra-violet radiations used therapeutically. The use of short-wave diathermy for heating of tissues and surgery offers scope for investigation. Some fundamental work has, in fact, recently been carried out on the electrical characteristics of tissues at ultra-high frequencies. Turning to quite a different field it is noteworthy that physicists are being appointed to deaf-aid clinics to assist in the solution of problems connected with hearing. Again, there are numerous problems in anaesthetics in which a physicist can be of fundamental assistance—problems concerned for example with the flow of gases in tubes or with

the production and dangerous effects of static electricity. In this connection a department of physics can take on responsibilities concerned with safety in operating theatres. The use of certain anaesthetic gases is highly dangerous unless precautions of a physical nature are enforced. Thus the proper earthing of electrical equipment, the use of non-sparking apparatus and the avoidance of the production of electrostatic charges are all of great importance.

Besides his clinical and scientific work, the hospital physicist is usually called upon to take part in teaching activities. Post-graduate medical students studying for qualifications in diagnostic or therapeutic radiology require an advanced knowledge of radiation physics for their diploma. The hospital physicist in daily contact with the practical applications of his subject is in an ideal position to give this instruction. Similarly radiographers in training for work in either diagnostic X-rays or radiotherapy will most appropriately receive their instruction in physics from a hospital physicist.

It will be clear from this brief summary that the assistance of technicians of various sorts is essential. The heart of a hospital physics department is its workshop and this must be well-equipped with machine tools and facilities for the usual workshop operations. One of its functions will be the production of specialized apparatus designed for a particular job. Such apparatus, built for use in clinical work or in the operating theatre must be of sound construction and well finished in every respect so that it is reliable in operation under adverse conditions. The physics technicians form an invaluable section of the staff without whom little progress could be made. In a small department there may be only one technician who must be correspondingly versatile and able to tackle instrument making, electronics and mould work. Such a requirement is almost impossible to fulfil and in a larger department these functions will be taken over by separate technicians specializing in their respective fields. Besides these there may be " radiographer-computers " dealing with the routine planning of treatment fields, " isotope radiographers " dealing with the routine measurement of radioactive isotopes and others working in close conjunction with the physicists.

The formation of the Hospital Physicists' Association and more recently the Hospital Physics Technicians' Association and their growth indicate the importance and rapid development of this branch of applied physics. In 1943 when the Hospital Physicists' Association was founded there were about 30 members. Now, after 10 years, the membership has grown to over 260. Not all of these work in hospitals, since membership is also open to physicists who work in medical and biological research establishments. The most important qualification of a hospital physicist is a high competence in physics, preferably an

Fig. 3 — Example of an instrument designed and constructed in a hospital physics department. A vibrating reed electrometer and accessories, in everyday use for all types of measurement involving ionizing radiation.

Honours degree and if possible some reserach experience. Knowledge of biological and medical subjects can usually best be learnt by working in an established department, though previous experience in biology is naturally valuable provided it has not been gained at the expense of physics. The earlier hospital physicists owed much to their radiotherapy colleagues for biological and medical instruction. Nowadays special courses are organized from time to time, such as those which have been held under the auspices of the Hospital Physicists' Association at Cambridge.

The would-be hospital physicist normally has choice of entry into the profession by two routes. He may apply immediately after graduating for a post in the Basic Grade at a hospital under the National Health Service. For the first two years he will be on probation. If at the end of this time he is regarded as satisfactory he will spend at least a further three years in the basic grade after which he may have the opportunity to enter the Senior, or later, the Principal Grade. The alternative approach is through post-graduate research in a medical school where a higher degree may be obtained and at the same time the atmosphere and experience of hospital work is absorbed. It is unfortunately difficult to organize fundamental research in the ordinary hospital physics department—the day to day clinical problems are too pressing. Nevertheless there is plenty of scope for development work in the design of new instruments and for investigations into the innumerable problems which arise in daily work. This is well shown by the number of contributions made by hospital physicists to scientific journals. Those who wish to concentrate on fundamental research will find opportunities in some of the larger hospitals, in the physics department of a Medical School, or in the research establishments of the Medical Research Council.

The interest in a subject so young and developing so rapidly is very great, and furthermore, many people find a great satisfaction in using their knowledge of physics to help suffering human beings. The expansion of the physicists' work, both in radiotherapy and in other specialities is at present becoming almost an embarrassment. Nevertheless, it is also a source of satisfaction since it is a sign of active growth in a subject whose value is becoming more and more widely appreciated.

It is a curious paradox, but nevertheless true, that we are more careful in what we say about atoms than we are in what we say about men.

D. ELTON TRUEBLOOD.

PROCEEDINGS OF THE THIRTY-FOURTH ANNUAL GENERAL MEETING

The Thirty-fourth Annual General Meeting of the Institute was held on May 18, 1954, at the Institute's House. The President (Dr. C. Sykes) was in the chair. A quorum being present, the Secretary read the notice convening the meeting. The Minutes of the previous Annual General Meeting held on May 29, 1953, were read and approved and were then signed by the Chairman.

On the proposal of the Honorary Treasurer (Dr. S. Whitehead) seconded by Dr. J. Topping (Fellow), the accounts and balance sheets for 1953 were unanimously adopted. The Honorary Secretary (Dr. B. P. Dudding) moved the adoption of the report of the Board for 1953 and this was seconded by Dr. P. S. Henry (Fellow) and carried unanimously.

Mr. R. G. Wood (Fellow) and Dr. S. A. Main (Fellow) were appointed scrutineers for the ballot for election to the Board. On receipt of their report the Chairman declared the following to be elected to fill the vacancies on the Board which will occur on September 30, 1954 :—

President : Sir John Cockcroft.
Vice-President : Mr. G. R. Noakes.
Honorary Treasurer : Dr. S. Whitehead.
Honorary Secretary : Dr. B. P. Dudding.
Ordinary Members of the Board : Mr. H. P. Rooksby,
Dr. K. A. G. Mendelssohn.

Messrs. Knox, Cropper and Co. were elected auditors for the year 1954.

Votes of thanks were moved to the President, Honorary Officers and members of the Board, the Honorary Officers of Branches and Groups and the many bodies which have allowed the use of their rooms during the year for meetings. These were carried with applause.

The meeting then proceeded to the Special Business of which due notice had been given.

The following resolutions were proposed by Dr. B. P. Dudding, seconded by Dr. J. Topping, and carried unanimously :—

Resolution 1 : That in By-law 21(c) the words " one guinea " be substituted for the words " one-and-a-half guineas."

Resolution 2 : That in By-law 24 the words " one guinea " be substituted for the words " one-and-a-half guineas."

This concluded the business of the meeting.

NOTES AND NOTICES

Graduateship Examination

The following modifications have been or are to be introduced in the regulations governing the Institute's Graduateship examination.

1. The High Vacuum Technology and Temperature Measurement options in the applied physics sections will be withdrawn after the 1955 examination.
2. New options in Applied Optics and Applied Heat will be available from 1956 onwards and the examiners would be prepared to consider requests for these options to be taken in 1955. Syllabuses will be published shortly.
3. The syllabuses in More Advanced Physics, Mathematical Physics, Electronics, X-Rays and Spectroscopy have been modified and copies of the new syllabuses will be available shortly. The 1955 examination will be set on the new syllabuses.
4. Holders of the London B.Sc. (General) degree at pass standard or of other university degrees listed in Schedule B (iii) of the membership regulations are normally required to take two papers of the Graduateship examination, one of these papers being More Advanced Physics. Hitherto, candidates have been permitted to offer Mathematics as the second paper. In future (1955 onwards) candidates whose degrees include Mathematics as one of the three subjects of the final examination will not be permitted to offer this subject in the Graduateship Examination. They will be required to take More Advanced Physics and one of the following :—Mathematical Physics, Statistics or any one of the Applied Physics papers. The papers to be taken by candidates whose degrees do not include Mathematics as a subject of the final examination will be decided by the Examiners in each individual case ; such candidates may be required to take Mathematics, More Advanced Physics and one other paper.

Gifts for the Institute's House

We have pleasure in announcing that through the good offices of Sir Hugh Warren, Managing Director of Associated Electrical Industries Ltd., and his colleagues, the Institute is to receive further gifts for its House in Belgrave Square ; the Research Laboratory of A.E.I. Ltd., through Dr. T. E. Allibone, the Research Laboratory of the Metropolitan-Vickers Electrical Co. Ltd., through Dr. Willis Jackson, and the Research Laboratory of the British Thomson-Houston Co. Ltd., through Mr. L. J. Davies, are helping us in connection with the House.

The first two Laboratories are each giving a sum of money which will provide additional furniture and equipment in accordance with the dignity of the House, and the details of these purchases will be announced in the Bulletin in due course. The other Laboratory has agreed to present—when deliveries can be made—one of the new and improved models of its 16 mm. film projector incorporating both magnetic and optical sound-heads. It is hoped that this will be available towards the end of the year, and an announcement will be made in the Bulletin later.

This tangible recognition of the Institute's services to these Research Laboratories, in which several of its members are working, is very much appreciated by the Board of the Institute, and will, we know, be gladly appreciated by the many Members who will derive benefits from these gifts.

The Institute's Crest

Reference was recently made at a meeting of the Board to the Institute's Crest, as used on its publications and other documents. This has been adapted, with several modifications over the course of years, from the design of the seal which is required to be used on various legal documents. It is felt by some that the Crest is inadequate and that a new one should be designed. The Board decided to take no action in the matter but to invite members who may be interested to submit suggested new designs for an Institute Crest. The Board proposes to consider the matter again early in 1955 in the light of any proposals put forward by members before the end of this year.

List of Members

The List of Members of the Institute, as at July 1, 1953, has now been published. It contains the names, qualifications, appointments and addresses of Fellows and Associates, and names and addresses of Graduates, Students and Subscribers. A copy will be sent, free of charge, to any member of any grade who requests one.

London and Home Counties Branch : Additional Meeting

Dr. Karl Darrow has accepted an invitation to address a meeting of the London and Home Counties Branch of the Institute while he is in this country for the meetings of the International Union of Pure and Applied Physics. The meeting will be held at the Royal Institution, Albemarle Street, on Thursday, July 1, at 6 p.m. Dr. Karl Darrow's subject is "Some Current Work at the Bell Telephone Laboratories." The meeting is open to all who are interested whether members of the Institute or not ; tickets of admission are not required.

NEWS OF MEMBERS

Fellows

SIR EDWARD APPLETON has received the honorary degree of Doctor of Laws from the University of Liverpool.

A. DINSDALE had been appointed Assistant Director of the British Ceramic Research Association.

PROFESSOR A. C. B. LOVELL has been awarded the Dudell Medal of the Physical Society.

PROFESSOR N. F. MOTT has been appointed Cavendish Professor of Experimental Physics in the University of Cambridge ; he has also been awarded a Royal Medal by the Royal Society.

DR. D. PARKINSON has been awarded the Colwyn Medal of the Institution of the Rubber Industry.

DR. R. W. POWELL has been promoted to be a Senior Principal Scientific Officer at the National Physical Laboratory, Teddington.

DR. J. TOPPING has been appointed Principal of Acton Technical College.

Associates

A. BAIRSTO has been appointed to the staff of Carlisle Technical College.

S. K. DATTA has been appointed General Manager of the Scientific Instrument Company Limited at Allahabad.

DR. W. L. HARRIES is now a research associate at the Massachusetts Institute of Technology.

E. D. HART has been appointed Deputy Director of The Scientific Instrument Manufacturers' Association, London.

H. HOWELLS is now with the Division of Atomic Energy of the Ministry of Supply as a physicist in the Health Physics Group.

J. T. KENDALL has been appointed a Research Leader with the Plessey Company at Towcester.

T. W. LINDOP has taken up an appointment with C. J. Whilems Ltd., Ilford Optical Works, Barkingside.

J. MCENHILL has been appointed a Principal Scientific Officer at the Atomic Weapons Research Establishment, Aldermaston.

G. K. MONKS is now a physicist at the Kent and Canterbury Hospital, Canterbury.

D. R. SCOTT is now a Lecturer in Fluid Mechanics at the University of Nottingham.

R. TEALE has been appointed Lecturer in Physics at Rotherham College of Technology.

Graduates

M. AINSWORTH has been appointed Principal Scientific Officer at the Ministry of Supply, Porton, Wiltshire.

D. R. ARNOTT has been posted as an Education Officer at R.A.F. Station, Compton Bassett, Wiltshire.

J. D. H. BRADLEY is now at the Sperry Gyroscope Company Ltd. as a Trials Engineer.

M. F. CULPIN has taken up an appointment as a Technical Assistant with British Nylon Spinners Ltd., Pontypool.

P. W. HOARD is now with Marconi's Wireless and Telegraph Company Ltd., Chelmsford.

D. SHREWSBURY is now a Spectroscopist in the Research Department of The Midland Tar Distillers Ltd. at Four Ashes, Wolverhampton.

P. B. WALLIS is now with the English Electric Company Ltd., Luton, as an Engineer.

REVIEWS OF BOOKS

Properties of Matter. By H. STEELS. (London : John Murray (Publishers) Ltd.) Pp. 214. Price 8s. 6d.

This is the second edition of a book first published in 1935. Additions have been made to the original text and a new chapter on " Diffusion and Osmosis " included. It is intended to cover the syllabi for intermediate as well as advanced and scholarship levels of the General Certificate of Education. The book contains a wealth of interesting descriptive matter, which should prove most stimulating to the student. Questions, selected almost exclusively from past examination papers of the Northern Universities Joint Board, appear at the end of each chapter.

The treatment of mechanics has been restricted to the second chapter and is presumably intended to serve as an introduction to the later work. In attempting to compress so much into one chapter a number of surprising omissions have been made, notably Newton's laws of motion, the conservation of linear and angular momentum, and a discussion of the similarity of the equations for translational and rotational motion. The most serious criticism, however, lies in the development of circular motion, in which, by reversing the centripetal force, problems are treated statically rather than dynamically. This procedure is mentioned in a footnote, but at this level particularly it is likely to prove most misleading even to a good student.

There are several less important features to which objection could be taken, but the general impression of the book might be summed up by saying that although physics teachers should find it useful and interesting, a satisfactory course could not be based on it without appreciable supplementation and occasional correction.

T. A. LITTLEFIELD.

Atomic Energy : A Survey. Edited by J. ROTBLAT. (London : Taylor & Francis Ltd.) Pp. 71. Price 6s. 6d.

Early in 1954 a series of public lectures on Atomic Energy was given at the University of London, organized by the Atomic Scientists' Association in collaboration with the Extra-Mural Department of the University. The object was to provide a survey of the state of development reached, and of the prospects for the future. The lectures were attended by a large and appreciative audience. This book presents the lectures in the form and order in which they were delivered, and makes them available to a wider public. This is especially so as the price is low, and publication has been rapid. The standard of production is adequate, and proof reading has been good.

Sir John Cockcroft provides an account of the various types of reactor and of the problems encountered in their design and construction. Professor Frisch deals with the principles involved in fast reactions leading to explosions, and Dr. Loutit with the hazards involved in the industrial application of atomic energy, and with their control. Perhaps the most stimulating lectures are those by Professor Simon and by Dr. Pochin. The former emphasises the necessity, especially in this country, for the development of atomic energy as a practical source of power, the approximate cost, the time scale, and the conditions and mental attitude necessary for success. Dr. Pochin gives a fascinating account of the value of radio-isotopes in medicine, both for diagnosis and for treatment. The final lectures, by Professor Lonsdale and Sir George Thomson, discuss the moral issues. The book, while intended primarily for the information of the public, will be of interest to the more specialist reader also.

D. A. WRIGHT.

The following reports have also been received :—

European Co-operation in Nuclear Research. (Paris, UNESCO ; London : Her Majesty's Stationery Office). Pp. 26. Price 1s.

Dutch-Norwegian Joint Establishment for Nuclear Energy Research, 2nd Annual Report (in English). Pp. 41.

The British Electrical and Allied Industries Research Association, 33rd Annual Report. Pp. 159.

The British Electrical and Allied Manufacturers' Association, 43rd Annual Report. Pp. 56.

The British Iron and Steel Research Association, Annual Report for 1953. Pp. 140.

THE REGISTER

ELECTIONS TO MEMBERSHIP

An asterisk (*) indicates transfer from another grade

Fellows

*Hughes, John William, B.Sc., Ph.D., Lecturer in Physics, University College, Cardiff.

*Kendall, James Tyldesley, B.A., Ph.D., Research Physicist, The Plessey Co. Ltd., Caswell, Towcester.

*Newby, Maurice Purcell, B.Sc., Head of Steel Casting Section, Physics Department, The British Iron and Steel Research Association, London.

*Sinclair, Warren Keith, M.Sc., Ph.D., Chief Physicist, M.D. Anderson Hospital, Texas Medical Centre, U.S.A.

*Tiffen, Ronald Walter, M.Sc., Ph.D., Lecturer in Mathematics, Birkbeck College, University of London.

*Williams, Sydney Ernest, M.Sc., Ph.D., Senior Lecturer in Physics, University of Western Australia.

Associates

Abbott, Alwyne, B.Sc., Quality Control Instrumentation Physicist, British Celanese Ltd., Spondon, Derbyshire.

*Aston, Alan John, B.Sc., Research Physicist, Dunlop Rubber Co. Ltd., Erdington, Birmingham.

Booker, Graham Roger, B.Sc., Research Investigator, Metropolitan-Vickers Electrical Co. Ltd., Manchester.

Bush, Harry Derrick, B.Sc., Ph.D., Senior Lecturer in Physics, Bradford Technical College.

*Copeland, Pamela Allen, B.Sc., Assistant Physicist, Baird & Tatlock (London) Ltd.

Cowlin, Philip, B.Sc., Research Scientist, British Scientific Instrument Research Association, Chislehurst.

*Dennis, Nigel Thomas Metcalf, B.Sc., Research Physicist, W. Edwards & Co. (London) Ltd.

*Fochs, Peter Derek, B.Sc., Ph.D., Research Physicist, Associated Electrical Industries Ltd., Research Laboratory, Aldermaston.

Griffiths, James Trevor, B.Sc., Assistant Physicist, United Birmingham Hospitals, The General Hospital, Birmingham.

Hall, Eric Ogilvie, M.Sc., Ph.D., Lecturer in Physics, University of Sheffield.

*Hanson, Alfred Wallace, M.A., Ph.D., I.C.I. Research Fellow, College of Technology, Manchester.

*Harris, James Hilary, B.Sc., Senior Assistant, Turner Bros. Asbestos Co. Ltd., Rochdale.

*Herbst, Ludwig Josef, B.Sc., Research Assistant, College of Technology, Birmingham.

*Hones, Anthony James, M.Sc., Assistant Lecturer in Physics, Mid-Essex Technical College, Chelmsford.

*Iles, Peter Albert, M.Sc., Physicist, Research Laboratories, The General Electric Co. Ltd., Wembley.

Jutsum, Peter John, B.Sc., Lecturer in Physics, University of Reading.

Kyte, Derek John, B.Sc., Temporary Senior Scientific Officer, Building Research Station, Garston.

*Little, John, B.Sc., Assistant, Department of Natural Philosophy, University of Edinburgh.

*Mallard, John Rowland, B.Sc., Ph.D., Senior Physicist, Hammersmith Hospital, London.

McRonald, Angus Duncan, B.Sc., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston.

Morgan, William Vivian, B.Sc., Research Physicist, H. Simon Ltd., Stockport.

*Morley, Frederick, B.Sc., Shop Manager (Health Physics), Springfields Works, Nr. Preston.

*Murphy, Jack Walter, B.Sc., Senior Engineer, Electric and Musical Industries Engineering and Development Ltd., Hayes.

*Patient, Derrick Arnold, B.Sc., Physicist, Baird and Tatlock (London) Ltd., Chadwell Heath, Essex.

Porter, Arthur, B.Sc., Senior Physics Master, Wolverhampton Grammar School.

*Radoslovich, Edward William, M.Sc., Research Officer, Division of Soils, Commonwealth Scientific and Industrial Research Organization, Australia.

Rieck, Gerard Daniel, Scientist, N.V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands.

Roberts, Arthur Raymond, B.Sc., Technical Officer, Imperial Chemical Industries Ltd., Widnes, Lancs.

Stern, Babette Esther, B.Sc., Physicist, Marie Curie Hospital, London.

*Sullivan, Neil, B.Sc., Assistant Development Engineer, Pyrene Co. Ltd., Aircraft Fire Research Laboratory.

Wainwright, Thomas, B.Sc., Scientist Grade III, National Coal Board, Worton Hall, Isleworth, Middx.

*Waugh, John Blake Steele, B.Sc., Experimental Officer, Dept. of Supply, Defence Research Laboratories, Alexandria, Australia.

Graduates

*Baines, Reginald Ernest Robert, B.Sc., Research Assistant, Telegraph Construction and Maintenance Co. Ltd., Greenwich.

Barrow, Colin Home, B.A., Assistant Physics Master, Bedford School.

Bennett, Anthony Wilfred, B.Sc., Research Engineer, Electric and Musical Industries Research Ltd., Hayes.

*Bishop, Kenneth Francis, B.Sc., A.R.C.S., Senior Scientific Officer, Atomic Energy Research Establishment, Harwell.

Clark, John Leslie, B.Sc., Research Student, University of Durham.

*Coomber, Derek Young, M.Sc., Technical Officer, Imperial Chemical Industries Ltd., Welwyn Garden City.

Dunster, Dave Francis Thomas, B.Sc., Research Physicist, Marconi's Wireless Telegraph Co. Ltd., Chelmsford.

Eadington, William Ronald, B.Sc., University of Durham.

Gough, Peter John Charles, B.A., Research and Development Physicist, Armstrong Siddeley Motors Ltd., Coventry.

Gregory, Norman Lennox, B.Sc., A.R.C.S., Assistant Engineer, De Havilland Propellers Ltd., Hatfield.

*Hall, Eric Walter, B.Sc., Research Student, University of Birmingham.

Hall, Michael Maurice James, B.Sc., Scientific Officer, British Dielectric Research Ltd., London.

*Hastings, Bernard Ratcliffe, B.Sc.

Healey, Gordon Terry, B.Sc., Technical Assistant, Armstrong Siddeley Motors Ltd., Coventry.

Henshaw, David Ernest, B.Sc., Post-Graduate Research, University of Western Australia.

James, Evan Lewis, B.Sc., Research Student, University College of Wales, Aberystwyth.

King, John Charles, B.Sc., A.R.C.S., Assistant Engineer, De Havilland Propellers Ltd., Hatfield.

Malos, John, B.E., M.Sc., Research Student, University of Sydney.

Massam, Leonard Albert, B.Sc., Research Physicist, Albert E. Reed & Co. Ltd., Aylesford Paper Mills, Maidstone.

*Matthews, Aubrey Royston, B.Sc., Research Student, University of Bristol.

McClements, Margaret Braney, B.Sc., Assistant, University of Glasgow.

*McKenzie, Alasdair Bell, A.R.T.C., Physicist, Research Laboratories, The General Electric Co. Ltd., Wembley.

O'Dell, Frederick Peter, B.Sc., Technical Assistant, Department of Atomic Energy, Springfields Works, Preston.

Pickard, Philip Leonard, B.Sc., Electronic Development Engineer, Taylor, Taylor & Hobson Ltd., Leicester.

Sheehy, Morgan Jerome, B.Sc., Teacher of Physics, Institute of Science and Technology, Dublin.

Spence, Graham, B.Sc., Research Physicist, The Carborundum Co. Ltd., Manchester.

*Strong, Robert William, B.Sc., Radio Valve Engineer, Ferranti Ltd., Manchester.

Webb, John William, B.Sc., Research Assistant, British Nylon Spinners Ltd., Pontypool.

DECEASED

We regret to record the deaths of the following, all of whom had been members of the Institute since 1920.

Fellows :

Prof. H. S. Allen, F.R.S.
Capt. A. Blackie
Prof. S. Brodetsky
Dr. R. S. Clay
Prof. F. L. Hopwood
W. J. Jones
R. S. Whipple.

Associate :

Capt. A. C. Jessup.

British Cotton Industry Research Association. There are the following vacancies at the Shirley Institute for honours graduates and graduates with higher degrees.
(1) A **physicist** or **mechanical engineer** to undertake fundamental and applied research on certain mechanical processes employed in textile finishing.
(2) A **physicist** or **textile technologist** for fundamental and technical researches in the process of doubling, which consists essentially of the twisting together of yarns. The successful candidate will be required to interest himself in the technical needs of the Industry and, under guidance, to develop his researches accordingly. Industrial experience, not necessarily in the textile industry, is desirable.
(3) A **physicist** or **research engineer** for research on weaving machinery. Knowledge of experimental stress analysis is desirable.

For the first of these appointments applications are invited from those doing National Service, from students taking degrees in 1954 and from people who expect to be available at some time before the end of 1954. Men with post-graduate experience will also be considered for this post. Posts 2 and 3 are more senior and some post-graduate experience is essential. The starting salaries are £500 to £550 for inexperienced graduates and up to £900 may be paid to more senior men. All posts carry superannuation benefits under the Federated Superannuation System for Universities.

Apply, giving full particulars, to The Director, Shirley Institute, Didsbury, Manchester, 20.

Physicists required by Research Organization establishing new laboratories in the Midlands, for researches mainly on deformation characteristics (viscous and elastic) of rubbers. Applicants must have degree with physics as a main subject. Starting salary in the range of £475 to £600 according to age and qualifications; promotion generally in accordance with Civil Service scales. Superannuation benefit for suitably qualified staff. Housing available at Shawbury for some applicants. Applications, which must give full particulars of age, qualifications and experience, to Secretary, Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Salop.

Young **metallurgical graduate** required in the research department. The post involves interesting duties in connection with the investigation of works processes in the production of carbon and alloy steels. A knowledge of statistics would be an advantage. Written applications, with full details of training and experience to date, should be addressed to **The Personnel Manager, Hadfields Ltd., East Hecla Works, Vulcan Road, Sheffield, 9.**

Development engineer. Vacancy in Design/Development Division for graduate (or equivalent). Suitable applicants would be those with sound knowledge of engineering, physics, or mathematics. Department covers wide range of engineering :—analysis and design of mechanisms, stress analysis, resonance and analysis of motion, spring design, optical development, etc., with limited research work. The division is situated at Elmdon, Birmingham, in ideal surroundings. Modern working conditions. Position carries monthly staff status with staff pension scheme. Applications in first instance to **Personnel Manager, Wilmot-Breedon Limited, Amington Road, Birmingham, 25.**

Research Assistant required at **The Royal Infirmary, Bradford,** preferably with a physics qualification or experience, for micro-radiography and X-ray diffraction research into the formation of renal calculi. Salary £300 p.a. Applications to be addressed for the attention of Dr. R. J. Carr.

Dunlop Rubber Company offer appointments to **chemists** for work associated with the development of new techniques, new materials and new processes. Applicants should preferably have an honours degree or its equivalent and should have completed National Service.

Applicants having special knowledge of, or interest in physical, colloid or high polymer chemistry, will be specially considered.

Such appointments can lead to responsible positions in the technical and production divisions of the Company both at home and overseas for candidates of merit and initiative.

Applications in writing, quoting reference J.M.39 giving details of age, qualifications and experience, to Personnel Manager, Dunlop Rubber Co. Ltd., Fort Dunlop, Erdington, Birmingham, 24.

Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17, has a vacancy for an **assistant spectrographer** in the metallurgical laboratory. Applicants should have B.Sc. and be interested in spectrographic techniques. Previous spectrographic or metallurgical experience an advantage. Salary, according to age, qualifications and experience, will be progressive. Write to the Personnel Manager, giving full particulars including age, sex, nationality, education and experience.

Research Association of British Rubber Manufacturers has a vacancy in the Intelligence Division for a **graduate** in chemistry or physics to undertake abstracting of technical literature, preparation of literature surveys, and other technical intelligence work. Preferred age 22 to 27. Starting salary £425 to £525 according to age and qualifications. Housing available at Shawbury for some applicants. Apply with full particulars of age, qualifications and experience to Secretary, R.A.B.R.M., Shawbury, Shrewsbury, Shropshire.

Physicist. Tootal Broadhurst Lee Co. Ltd. have a vacancy in their research department for a young honours graduate or Ph.D. in physics. The work involves research in connection with all textile fibres and gives an opportunity for initiative and independent work on long-term projects. Knowledge of textiles is desirable but by no means essential. Initial salary according to qualifications and experience; pension and profit sharing schemes apply. Applications to the Personnel Manager, 56 Oxford Street, Manchester 1.

Graduate physicist required for experimental investigations. The vacancy is on the staff of the central research laboratory of a large group of companies but the successful candidate will also be required to carry out works' investigations. Applications, giving full details in writing, should be made to the **Director of Research, G. K. N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton.**

The British Iron and Steel Research Association. Physicist required by the above Association to carry out fundamental investigations into new methods of casting steel by continuous processes. The work will require research into heat transfer between molten metal and water-cooled surfaces and into the origin and control of frictional forces at the surface of solidifying metal. The ability to help in the development of automatic control systems would be an advantage, together with some metallurgical knowledge, but neither is essential. Candidates should have an honours degree in physics. Age range 25–31. Starting salary up to £900 p.a. according to age, qualifications and experience. The work will be mainly located in Sheffield but there will be an initial period of training at the Association's Laboratories in London. Post is superannuated under the F.S.S.U. Written applications only quoting "Casting" to Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1.

Large British Oil Company has vacancies for **Geophysicists** on its exploration staff. Candidates should have an honours degree in physics with subsidiary mathematics and/or geology, but candidates with a general degree will be considered. The work involves delineation of underground rock structure by seismic, gravitational and magnetic techniques and offers considerable scope for men with initiative who are prepared to travel and to work abroad. Normal leave is four months after two years' foreign service.

When conditions permit, facilities are afforded for married men to have their families with them on foreign tours.

Basic salary is commensurate with age and experience, commencing at £820 for young, inexperienced graduates. Appropriate allowances are paid whilst on foreign service. Generous pension scheme.

Applications quoting F.107, should be addressed to **Box 1131, c/o 191 Gresham House, E.C.2.**

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